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1994-95 School Year

Biology 30 Information Bulletin

Diploma Examinations Program

Students
First!
Student Evaluation

Alberta
EDUCATION

This document was written primarily for:

Students	✓
Teachers	✓ Biology 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta Education • General Public upon Request

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Contents

Page

1 *PURPOSE OF THE BULLETIN*

GENERAL INFORMATION

2 1995 Grade 12 Diploma Examinations Schedule
2 1995 Marking Information
2 1994–95 Field Testing and Item Writing
NEW *3* Format of the Sciences Examinations
NEW *3* Assessment of Skills and STS Connections
NEW *4* Standards
4 Use of Scientific Calculators on Examinations
NEW *4* Rescores
4 Examiners' Reports
4 School and Jurisdiction Statistical Reports
4 Annual Report

NEW *BIOLOGY 30 INFORMATION*

5 Standards
6 Examination Specifications
7 Examination Design
8 Special Instructions

NEW *SAMPLE TEST ITEMS, SCORING CRITERIA, AND SAMPLE ANSWERS*

16 Sample Test
26 Scoring Criteria for the Written-Response Question
29 Sample Answers to the Written-Response Question

APPENDICES

REVISED *31* *Appendix A* Policy: Use of Scientific Calculators on Alberta Education Diploma Examinations
REVISED *32* *Appendix B* Examination Rules, Grade 12 Diploma Examinations
33 *Appendix C* Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics and Sciences Diploma Examinations
REVISED *34* *Appendix D* Explanations of Cognitive Levels Directing Words
36 *Appendix E* Preparing to Write a Science Diploma Examination—What every student should do before the examinations!
37 *Appendix F* Suggestions for Students When Writing Science Diploma Examinations—What every student should know when writing examinations!
NEW *38* *Appendix G* Specific Prerequisite Concepts and Skills for Biology 30
NEW *41* *Appendix H* STS Connections, General Learner Expectations, and Enablers for Item Writing

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Purpose of the Bulletin

The purpose of science bulletins is to provide students and teachers of the sciences with information about the diploma examinations scheduled for 1995. Science bulletins include descriptions of the examinations in the sciences that will be administered in January, June, and August of 1995; they outline the objectives to be tested and provide information about the design of the examinations. They provide guidelines for completing the machine-scored answer sheets, use of calculators, and the manipulation of data. Definitions of directing words, which are used to convey expectations for students' responses to exam questions, are given in the appendices along with suggestions for students when preparing for writing diploma examinations.

The bulletins describe the acceptable standard and the standard of excellence for Biology 30, Chemistry 30, Physics 30, and Science 30. These descriptions will give readers a general impression of the levels of achievement expected of students in each of the 30-level science courses.

The revised courses in Biology 30, Chemistry 30, and Physics 30 are being implemented this school year (1994–95). The revisions in these courses have implications for the design of the corresponding diploma examinations. Specific information concerning achievement expectations, sample questions, scoring criteria, and sample answers are provided in the bulletin for each of these courses.

The new Science 30 course is also being implemented this school year. All schools that offer the Science 30 course will be provided with year-end pilot tests. These tests will be prototypes of the Science 30 diploma examinations that will be administered starting the following school year (1995–96). Specific information concerning achievement expectations, sample questions, scoring criteria, and sample answers are provided in the bulletin for Science 30.

The Science 30 year-end pilot tests will be written according to the 1995 Diploma Examination Schedule, scored in the schools, and then returned to Alberta Education. The students' final course marks will be awarded by the school and will incorporate a 25% minimum weighting of the pilot test score. Students' marks on year-end pilot tests will not be reported separately to Information Services.

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff is available to provide inservices or presentations related to diploma examinations or the interpretation of diploma examination results.

If you have requests, questions, or comments about the contents of this bulletin, please contact:

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General Information

1995 Grade 12 Diploma ExaminationsSchedule

Date	*Time**	*Examination*
Thurs., Jan. 26	9:00–11:30 A.M.	Biology 30
	1:00–3:30 P.M.	Physics 30
Fri., Jan. 27	9:00–11:30 A.M.	Chemistry 30
	1:00–3:30 P.M.	Science 30 Pilot
Tues., June 27	9:00–11:30 A.M.	Biology 30
	1:00–3:30 P.M.	Physics 30
Wed., June 28	9:00–11:30 A.M.	Chemistry 30
	1:00–3:30 P.M.	Science 30 Pilot
Tues., Aug. 15	1:00–3:30 P.M.	Chemistry 30
Wed., Aug. 16	1:00–3:30 P.M.	Science 30 Pilot
Thurs., Aug. 17	9:00–11:30 A.M.	Biology 30
	1:00–3:30 P.M.	Physics 30

*The diploma examinations are designed for a writing time of 2.5 hours. Students will have an additional 0.5 h to complete the examinations.

There are no changes to the examination requirements. It is expected that 2.5 hours is adequate for each examination; however, the extra 0.5 hour is available for those students who need it.

1995 Marking Information

The written-response questions of the diploma examinations in the sciences are marked by classroom teachers. These markers are selected from teachers who have been recommended by their superintendents. To qualify for recommendation in all subjects except Science 30, a teacher must have taught the subject for two or more years, be currently teaching the subject, and have an Alberta Permanent Professional Certificate.

For Science 30, a teacher must have taught the subject previously or be currently teaching the subject, and have a valid Alberta Permanent Professional Certificate.

The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (generally, first-time markers are given priority)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation
- gender balance

We particularly need teachers who can mark examinations written in French.

Teachers who wish to be recommended as markers for the January 1995 examinations should contact their superintendents before October 1, 1994. Teachers who wish to be recommended as markers for the June and August 1995 examinations should contact their superintendents before March 1, 1995

Tentative dates for marking of the 1995 science diploma examinations are:

January Administration	February 7 to 11
June Administration	July 10 to 14
August Administration	August 18 to 19

1994–95 Field Testing and Item Writing

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Teachers who are interested in these activities should let their superintendents know early in the school term.

Format of the Sciences Examinations

All examinations in the four sciences have both machine-scored questions and teacher-scored (written-response) questions.

The machine-scored questions are of two types: multiple-choice and numerical-response. Please refer to the *Biology 30 Information* section of this bulletin for further details about numerical-response questions.

Each examination in the sciences has two written-response questions. At least one of these will be an open-response question. Students' answers to open-response questions are scored by teachers using holistic scoring guides. These guides describe the characteristics of students' answers that correspond to one of five values: 0, 1, 2, 3, or 4. Each student's answer is scored independently by two teachers. The two sub-scores are added together for a combined total raw score.

The other written-response question on each examination may be a closed-response question. Students' answers to closed-response questions are scored by teachers using analytical scoring keys. Each student's answer is scored by only one teacher.

Examination questions are organized into related sets. A set may be introduced by a general scenario that serves as an organizer for one or more contexts. This introductory statement will be screened.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

If required, a screened bar will indicate the end of a set.

A separate data booklet is provided for the Chemistry 30 and Science 30 (Pilot) examinations. The Biology 30 and Physics 30 examinations contain tear-out data pages. All examinations in the four sciences have tear-out pages for rough work.

Assessment of Skills and STS Connections

Students' understanding of the concepts of science are measured by every question on the examinations. In addition, some questions measure the students' development of the skills and thinking processes associated with scientific inquiry. Some questions will measure students' understanding of the interrelationships between science and technology and among science, technology, and society.

Communication skills are assessed most directly in the teacher-scored questions. For some closed-response questions, in addition to the analytical scoring key, a separate holistic scoring guide may be used. For the open-response questions, the descriptions used in the holistic scoring guides may include criteria for assessing communication skills along with criteria for the other components. Examples of scoring criteria can be found on pages 26 and 27.

The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include:

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific.

Standards

Standards in education are statements that communicate the level of performance necessary to attain a specific goal or objective. Standards assist educators in determining the extent to which students must know content and demonstrate required skills to pass the course.

Standards of student achievement are described in general at the beginning of the *Biology 30 Information* section. These standards are applicable to students who attain the *acceptable* standard (a final mark of 50% or higher) and to students who attain the standard of *excellence* (a final mark of 80% or higher).

A more detailed description of specific learner expectations (standards) accompanied by sample questions, answers, scoring criteria, and samples of student responses is given in the *Sample Test Items, Scoring Criteria, and Sample Answers* section.

Use of Scientific Calculators on Examinations

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students.

Please refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Also consult the *Biology 30 Information* section. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see Appendix B). Students should know that notes stored in electronic devices may not be brought into the examination room.

Rescores

A student may request a rescoring of the diploma examination if he or she believes that the mark received is not appropriate. However, before applying for a rescoring, it is important to check the distribution of marks in the examination. The machine-scored mark is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Examiners' Reports

Following the administration of the January and June examinations, examiners' reports are released. These reports briefly outline the statistical data obtained from the examination administration and provide a diagnostic overview of student performance. Examiners' reports are designed for teacher use. If we can make these reports more useful to you, please let us know.

School and Jurisdiction Statistical Reports

Superintendents and principals receive detailed statistical reports on how well the students in their school district did on the sciences examinations. Teachers use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Annual Report

A document entitled *Annual Report, Diploma Examination Program,* that summarizes results from the January, June, and August diploma examination administrations is published each year. The purpose of this report is to inform educators and the public about student achievement in relation to provincial standards.

Biology 30 Information

Standards

Students of Biology 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of biological concepts by their increased ability to apply these concepts to relevant situations. They have learned to communicate in the specialized language of biology.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, in particular by the successful completion of Science 10 and Biology 20. These courses develop knowledge and skills that are prerequisite to success in Biology 30 (See Appendix G).

Students who attain an *acceptable* standard of performance in Biology 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific inquiry by designing, observing, and interpreting simple laboratory and field investigations. They can readily interpret physiological, genetic, and ecological data that are presented in simple diagrams, tables, and graphs. They can translate word descriptions of biological processes into symbolic representations that facilitate solving simple quantitative genetic and ecological problems. These students can demonstrate an acceptable level of understanding of *equilibrium* by describing how the human nervous and endocrine *systems* regulate other body processes such as reproduction. They can show how environmental and genetic factors regulate *change* in the development of organisms. They can describe how cellular and molecular processes cause *diversity* in organisms. They can illustrate how populations interact with each other, thereby forming communities that over time are in *equilibrium* or a state of *change*. These students recognize and understand key biological and technological terms and therefore can interpret short reports of current biological issues. They can identify the scientific, technological, and societal components of biological problems and explain how these components interrelate in solutions. These students can compose clear and logical descriptive or explanatory statements about major biological issues.

Students who attain a standard of *excellence* in Biology 30 receive a final mark of 80% or higher. Besides meeting the expectations for an acceptable standard of performance, these students demonstrate their aptitude and interest in biology and feel confident about their abilities. They can readily interpret interrelated sets of data such as complex graphs and tables. They can analyze and evaluate experimental designs. These students can provide explanations of concepts that are specific but also comprehensive. They can simultaneously apply two or more biological concepts that cross major themes. They can demonstrate a thorough understanding of quantitative relationships and solve multistep numerical problems. When presenting scientific data, they select the most appropriate form. They can analyze complex open-ended issues that are of a new or unique nature. The contexts of these issues would most likely include current investigations of homeostatic mechanisms or current genetic research. Exceptional students can communicate clearly and concisely, using appropriate scientific vocabulary, and can write compositions.

Examination Specifications

The 1995 Biology 30 diploma examinations are constructed to place the following approximate emphases on the Biology 30 Course General Learner Expectations.

Knowledge The student can show that:	***Emphasis***
• humans use nervous and endocrine systems to maintain internal equilibrium among their systems while simultaneously interacting and maintaining equilibrium with the external environment	20–25%
• humans and other organisms have chemically regulated reproductive systems, which ensure survival of the species, and can describe how sexually transmitted diseases interfere with human reproductive function	10–15%
• cell differentiation and organism development are regulated by genetic and environmental factors and that natural processes can be changed by using reproductive technologies	5–10%
• cell division in vascular plants and animals promotes growth, genetic continuity, and diversity of organisms; and that genetic traits are inherited and expressed in predictable ways if chromosome segregation, assortment, and crossing over are taken into account	25–30%
• genetic information stored in DNA molecules directs the functions of organisms and that biotechnology can be used to influence genetic expression	10–15%
• gene frequencies within populations determine the composition of communities and that these gene frequencies may reach equilibrium or continue to change over time as populations interact	15–20%

Skills — ***Emphasis***

The student can: 20–30%

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Connections Among Science, Technology, and Society (STS) — ***Emphasis***

The student can: 20–30%

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory, and explain the limitations of science and technology in answering all questions and solving all problems
- describe and evaluate the design and function of technological solutions to theoretical and practical problems, and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society, and assess the ability to interact responsibly with the environment
- apply the skills and knowledge acquired in science to everyday life

Each Biology 30 Diploma Examination is designed to reflect the *Biology 30 course* general learner expectations outlined in the *Biology 20-30 Program of Studies, Interim, for Senior High Schools*. The general learner expectations are expressed in more detail by the specific learner expectations, which are organized into four units. Some questions on each diploma exam will assess achievement of specific learner expectations and some will be based on the integration of the specific learner expectations.

Integration of General Learner Expectations (GLEs)

Examination questions are organized into related sets. All the questions in a set may relate to a broad context. Therefore, the set of questions may assess students' ability to integrate several GLEs. All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and /or STS connections.

Examination Design

The design of the 1995 Biology 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	48	60
Numerical Response	8	10
Written Response	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Most of the multiple-choice questions are *context-dependent*.

A particular context may be used for more than one multiple-choice question, one or more numerical-response questions, as well as for one written-response question.

Answers for multiple-choice questions are recorded in Part A of the machine-scored answer sheet, and answers for numerical-response questions are recorded in Part B of the same machine-scored answer sheet. Answers to the written-response questions are written right in the exam booklet.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a list, and determination of a sequence of events. Specific instructions for recording answers for each type of numerical-response question, as well as examples of each type, are provided later in this bulletin. It should be noted that the correct answer for any one question will not necessarily require use of all four columns in the grid.

The written-response portion of each Biology 30 diploma examination contains two contextual questions: a closed-response question and an open-response question. Each question has a value of 15 per cent.

The closed-response question presents a synopsis of a research project. Pertinent data are provided in the form of graphs and/or tables. The several parts of this question require students to demonstrate a variety of science process skills.

The open-response question presents a problem that requires students to make connections between biological concepts, technology, and/or social issues. Furthermore, an acceptable response will demonstrate good communication skills.

Special Instructions

Clarification of Word Usage in Examinations

In past examinations, a number of terms used in the context of scientific process skill questions have confused some students. A sample of such terms with their preferred definitions follows.

Hypothesis: A single proposition intended as a possible explanation for an observed phenomenon; e.g., a possible cause for a specific effect.

Conclusion: A proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence.

Experiment: A set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations.

Variables: Conditions that can change in an experiment. Variables in experiments are categorized as:

- *manipulated variables* (independent variables)—conditions that were deliberately changed by the experimenter
- *fixed or restrained variables* (controlled variables)—conditions that could have changed but did not, because of the intervention of the experimenter
- *responding variables* (dependent variables)—conditions that changed in response to the change in the manipulated variables

For additional clarification of the specialized terms used to describe science process skills, see Al Gibbs, Anton E. Lawson, "The Nature of Scientific Thinking As Reflected by the Work of Biologists & by Biology Textbooks," *The American Biology Teacher*, March 1992, Volume 54, Number 3, page 137.

Technology: The development of our understanding of human physiology is directly related to the development of technology. The meaning of technology has many facets, but in general, technology refers to a way of doing something. This includes the development of tools and new techniques for solving problems. It also includes ideas and their organization for achieving practical purposes. In the context of an examination question, technology includes both these facets of meaning. That is, a technological explanation should include not only identification and descriptions of equipment (tools, products) but also explanations of procedures.

Directing Words

Students are advised to review the meaning of directing words as defined in Appendix D. These words will be used in the instructions given for responding to most items in the examinations, particularly in the written-response section.

Calculators

Students are expected to provide their own scientific calculators. The scientific calculators shall not be used by students to store notes in any form.

Tear-Out Data Pages

Students should remove the *tear-out data pages* from the exams at the beginning of the writing session. These pages do not have to be returned with the exam booklets and answer sheets. The data presented are generic for all of the Biology 30 diploma exams provided during a school year; therefore, only some of the data are useful for any particular exam.

Biology 30 Data

Symbols

Symbol	Description
A	area
B	births during time interval
b	per capita births $\left(B/N\right)$
D	deaths during time interval
d	per capita deaths $\left(D/N\right)$
D_p	population density
K	carrying capacity
N	population size
ΔN	change in population size
$PG\%$	population growth (percent)
r	per capita population growth rate $(b-d)$
V	volume

Symbol	Description
$>$	greater than, dominant over
$<$	less than, recessive to
$=$	equal to, codominant with, incompletely dominant with
/	divided by, "out of"
×	multiplied by, times, crossed with, mated with
Δ	change
♂	male
♀	female
n	chromosome number
I^A, I^B, i	alleles (human blood type) ABO system ($I^A = I^B$, $I^A > i$, $I^B > i$)
t	time
Δt	change in time

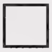
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{V}$ or $D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Population growth (%)	$PG\% = \frac{\Delta N \times 100\%}{N}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols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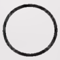
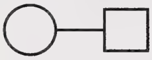
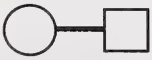
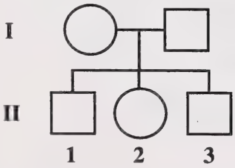
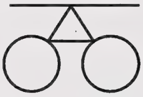

Female

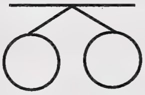

Mating

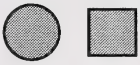

Mating between close relatives

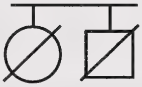


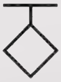
Offspring listed in birth order. Roman numerals symbolize generations. Arabic numbers symbolize birth order within generation.


Identical twins


Non-identical twins


Affected individuals


Deceased offspring


Offspring of unknown sex

Messenger RNA Codons and Their Corresponding Amino Acids

	SECOND BASE								
FIRST BASE	U		C		A		G		THIRD BASE
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	C
	UUA	Leu	UCA	Ser	UAA	STOP**	UGA	STOP**	A
	UUG	Leu	UCG	Ser	UAG	STOP**	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	C
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	A
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	C
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	A
	AUG	Met or START*	ACG	Thr	AAG	Lys	AGG	Arg	G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	C
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	A
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	G

* Note: AUG is an initiator codon but also codes for the amino acid Methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Amino Acids

Amino Acid	Abbreviation
Alanine	Ala
Arginine	Arg
Asparagine	Asn
Aspartate	Asp
Cysteine	Cys
Glutamate	Glu
Glutamine	Gln
Glycine	Gly
Histidine	His
Isoleucine	Ile
Leucine	Leu
Lysine	Lys
Methionine	Met
Phenylalanine	Phe
Proline	Pro
Serine	Ser
Threonine	Thr
Tryptophan	Trp
Tyrosine	Tyr
Valine	Val

Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

Format of Numerical-Response Questions on Biology 30 Examinations

One or more numerical-response questions follow a title printed in inverse type.

Numerical Response

Question numbers for numerical-response questions are printed in inverse type.

1.

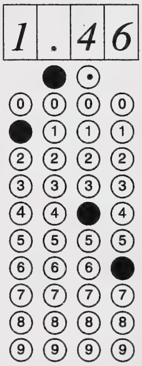
Each question has a place for the student to record an answer before recording it on the answer sheet.

Answer: _____ (Record your answer to three significant digits in the numerical-response section of the answer sheet.)

Recording Answers for Numerical-Response Questions

The student enters an answer beginning in the left-most box of the grid provided on the answer sheet for each numerical-response question. Sometimes an answer will **not** contain four digits. Any unused boxes are to be left blank. The student then shades the appropriate bubble below each box using an HB pencil. A decimal point can be recorded only in the two columns in the centre of the grid.

Sample Grid for a Numerical-Response Question



Numerical-Response Questions with Answers that are Determined by Calculation

Students are expected to follow the guidelines for significant digits, manipulation of data, and rounding provided in Appendix C. Students will be directed to provide a specific number of significant digits. The number of digits requested does not include the decimal point or a leading zero. A leading zero, although not significant, must be recorded if the answer is a value between 0 and 1. Units or negative signs are never recorded.

Example:

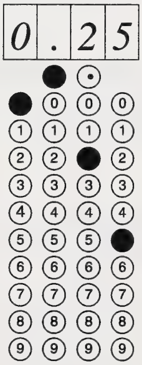
Numerical Response

2. In peas, tall is dominant over short. If two heterozygous tall pea plants are crossed, what is the probability that short offspring will be produced?

Answer: 0.25 (Record your answer to two significant digits in the numerical-response section of the answer sheet.)

Notice that in the answer to this question, the leading zero is recorded.

The word "probability" in the stem of this question indicates that a value from 0 to 1 inclusively is required. If a percent is required, this will be indicated in the stem.



Numerical-Response Questions with Answers Selected from a List of Items

Some numerical-response questions will direct the student to select numbered items from a list. Students should select only those items that meet the criteria provided in the stem. Depending on the question, the correct answer could contain one, two, three, or four digits. Answers are recorded in ascending numerical order.

Example:

Numerical Response

3. Which of the animals named in the list at the right are mammals?

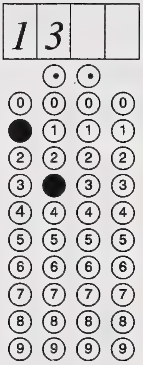
Some Animals

1 Dog
2 Lizard
3 Donkey
4 Frog
5 Butterfly

Answer: 1 3 (Record your answer in ascending numerical order in the numerical-response section of the answer sheet.)

Notice that the answer to this question is recorded beginning in the left box. Unused boxes are left blank.

In this question, students are not told how many animals to select. They must determine how many are correct.



Numerical-Response Questions with Answers Derived by Determining a Sequence of Events or Structures

Some numerical-response questions will direct students to select events or structures from a list and determine the correct sequence in which the events occur or the structures are used. Students should select and determine the correct sequence of only those events or structures that meet the criteria provided in the stem. Depending on the question, the correct answer may contain two, three, or four digits. The answer is recorded in the correct sequence.

Example:

Numerical Response

4. From the list of parts at the right, provide the correct sequence in which light passes through a microscope to reach the eye of an observer.

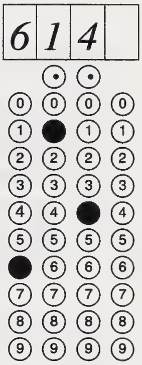
Some Parts of a Microscope

1 Objective
2 Arm
3 Coarse adjustment knob
4 Eyepiece
5 Fine adjustment knob
6 Diaphragm

Answer: 6 1 4 (Record your answer in the numerical-response section of the answer sheet.)

Notice that the answer to this question is recorded beginning in the left box. Unused boxes are left blank.

In this question, students are not told how many parts to select. They must determine how many selections are appropriate and record them in the correct sequence.



Sample Test Items, Scoring Criteria, and Sample Answers

Sample Test

Use the following information to answer the next three questions.

Contextual information must be factual, brief, and relevant to the program of studies.

> Many drugs produce effects on the body by interfering with the functions of the nervous system. The following are four examples.
>
> - Amphetamines cause excessive release of excitatory neurotransmitters.
> - Cocaine enhances the functioning of excitatory neurotransmitters by preventing their inactivation.
> - LSD makes ineffective the functioning of certain excitatory neurotransmitters.
> - Valium increases the effectiveness of inhibitory neurotransmitters.

Answer: D
Acceptable standard
Diff. = 0.547*

1. The information indicates that all of these drugs

A. cause an increase in the size of the action potential
B. inactivate the sodium/potassium pump
C. change the threshold of an axon
D. affect the synapse

Answer: D
Standard of excellence
Diff. = 0.720

2. Which drugs would act as depressants?

A. Amphetamines and cocaine
B. Amphetamines and LSD
C. Valium and cocaine
D. Valium and LSD

Answer: A
Acceptable standard
Diff. = 0.475

3. Which hypothesis best explains the effect of cocaine on the nervous system?

A. Cocaine deactivates cholinesterase.
B. Cocaine deactivates acetylcholine.
C. Cocaine activates cholinesterase.
D. Cocaine activates acetylcholine.

*Note: "Diff." refers to difficulty. In this case, 54.7% of students responded correctly.

Use the following readings to answer the next 4 questions.

Reading 1

In the beginning, Robert Rosen created a kind of primordial soup. Mimicking origin-of-life experiments performed in the 1950s, he concocted a stew of amino acids, the building blocks of proteins. He cooked and evaporated and synthesized. Then he looked down at what he had created — shimmering microscopic spheres made of protein-like material — and he said to his boss, "It is good." The idea was to make fish oil more palatable by packing the vile-tasting vitamin supplement inside tiny, flavourless spheres that could slip uneventfully past the taste buds.

Rosen's boss thought such a product would make his company rich, but Rosen had other ideas. What Rosen thought about was insulin. Rosen, a diabetic, had definite opinions about needles: "I'd love to take a pill instead of a shot." So he filled his bubbles with insulin.

Reading 2

There are two big drawbacks to transplant surgery — the tendency of the body's defenses to reject foreign tissue and the shortage of donors with organs to give. Scientists in America claim to have found a way around both. They take tissue from an animal and wrap it in plastic before transplanting it into another animal. If this technology proves to be successful, it may be tried on humans suffering from diabetes.

4. If transplanted endocrine tissue provided a diabetic person with insulin, it is likely that the transplanted tissue would also provide that person with

A. adrenaline
B. thyroxine
C. glucagon
D. cortisol

Answer: C
Acceptable standard
Diff. = 0.810

5. The plastic used to wrap transplanted tissue prevents rejection but still allows the tissue to function. This information implies that the plastic is

A. permeable to antibodies
B. impermeable to glucose
C. permeable to white blood cells
D. impermeable to large protein molecules

Answer: D
Standard of Excellence
Diff. = 0.318

Continued

Answer: B
Acceptable standard
Diff. = 0.782
(Note the carryover from Biology 20.)

6. Robert Rosen filled bubbles with insulin to protect the insulin from the action of the

A. liver
B. stomach
C. pancreas
D. large intestine

Answer: C
Acceptable Standard
Diff. = 0.765

7. Readings 1 and 2 describe technologies that might be used when which gland fails to function normally?

A. Thyroid
B. Pancreas
C. Pituitary
D. Hypothalamus

Use the following information to answer the next question.

> A study by Niels Skakkebaek from Denmark has found evidence for an alarming decline in testicular productivity and a tremendous increase in testicular cancer. The study showed that, in Danish men, ejaculatory volume has decreased 20% and sperm count fallen by 40% in the last 50 years. Skakkebaek cites exposure to toxic chemicals as the cause.

Answer: D
Acceptable standard
Diff. = 0.382

8. Reduced sperm production indicates that toxic chemicals damage the

A. prostate gland
B. interstitial cells
C. seminal vesicles
D. seminiferous tubules

Use the following information to answer the next question.

Some Events Occurring in the Reproductive Process of a Female (Arranged in Random Order)

1 Pituitary is signaled to continue output of FSH
2 Pituitary is signaled to stop output of FSH
3 Corpus luteum disintegrates
4 Corpus luteum remains functional
5 Degenerative changes in the endometrium are inhibited
6 Degenerative changes in the endometrium occur

Numerical Response

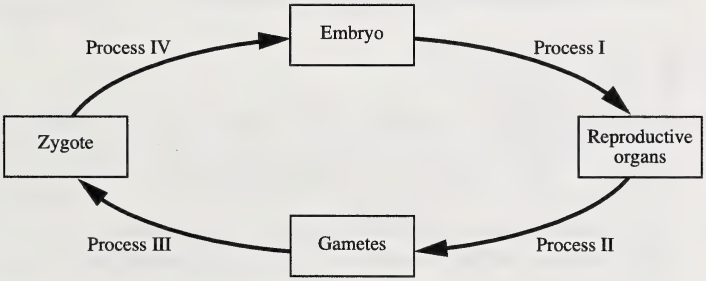
1. If implantation of an embryo occurs, the sequence of events which normally follows is ___________

(Select the appropriate events and record them in the numerical-response section of the answer sheet in the correct sequence.)

Answer: 2, 4, 5
Acceptable standard
Diff = 0.480
(Note that the student must select and sequence three events. Any unused spaces on the answer sheet are left blank.)

Use the following diagram to answer the next question.

The Life Cycle of Organism "X"



9. Process II in the diagram represents

A. mitosis and the formation of diploid cells
B. meiosis and the formation of haploid cells
C. fertilization and the formation of a haploid cell
D. cell differentiation and the formation of diploid cells

Answer: B
Acceptable standard
Diff. = 0.606

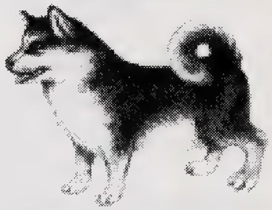
Use the following information to answer the next three questions.

In Alaskan Malamute dogs, a recessive gene causes a condition in which a dog’s leg cartilage fails to develop properly. This results in dwarfism. Dogs that carry a dominant allele are of normal height.

In the same breed of dogs, a curled tail is dominant over an uncurled tail.

The alleles for height and tail curl are found on independent homologous chromosomes.

Dwarf Malamute



Malamute of Normal Height

Answer: B
Acceptable standard
Diff. = 0.710

10. What are the genotypes of a true-breeding dwarf malamute and a hybrid normal-height malamute, respectively?

- **A.** dwarf and normal
- **B.** dd and DD
- **C.** dd and Dd
- **D.** d and D

Answer: B
Acceptable standard
Diff. = 0.789

11. Which observation would be true about a cross between a dog that is heterozygous for height and tail curl and a dog that is recessive for both traits?

- **A.** None of the offspring would have a recessive trait.
- **B.** None of the offspring would be homozygous for a dominant trait.
- **C.** All of the offspring would all show at least one of the two recessive traits.
- **D.** All of the offspring would all show at least one of the two dominant traits.

Continued

Numerical Response

2. A cross between two dogs, both of which are heterozygous for height and tail curl, would likely produce which phenotypic ratio in the offspring?

Answer: 9, 3, 3, 1
Acceptable standard
Diff. = 0.780

Answer:

Normal height-curled tail	Normal height-uncurled tail	Dwarf-curled tail	Dwarf-uncurled tail

(Record your answer in the numerical-response section of the answer sheet.)

Numerical Response

3. The gene for Tay-Sachs disease is recessive and is located on chromosome 15. If a man and a woman are heterozygous for Tay-Sachs disease, what is the probability that their first-born child would be a girl that is heterozygous for Tay-Sachs disease?

Answer: 0.25
Standard of excellence
Diff. = 0.414
(Note that probabilities are reported as values from 0 to 1.)

Answer: ____________

(Record your answer to two significant digits in the numerical-response section of the answer sheet.)

12. In 1942, Charlotte Auerback demonstrated the undesirable effects of mustard gas used in chemical warfare. This gas caused faulty nitrogen-base pairing during DNA replication. Which sequence of nitrogen-base pairs might result from exposure to mustard gas?

Answer: B
Acceptable standard
Diff. = 0.850

A.
```
-A-T-G-A-A-T-
 | | | | | |
-T-A-C-T-T-A-
```

B.
```
-G-C-A-C-C-G-
 | | | | | |
-C-G-T-G-C-G-
```

C.
```
-A-A-A-T-T-T-
 | | | | | |
-T-T-T-A-A-A-
```

D.
```
-C-G-C-A-G-A-
 | | | | | |
-G-C-G-T-C-T-
```

Use the following information to answer the next two questions.

This pair of questions integrates two general learner expectations.

Not So Super "Supersalmon"

Researchers at Memorial University in Newfoundland have successfully inserted a foreign "growth factor" gene into Atlantic salmon. This gene should produce larger salmon in a shorter period of time. Although the gene was successfully inserted into the salmon genome, it was not expressed.

Answer: B
Standard of excellence
Diff. = 0.622

13. What is a possible reason for the observed outcome?

A. The inserted gene contained uracil instead of thymine.
B. The initiator codon for the gene was missing.
C. The gene was inserted into somatic cells.
D. The inserted gene was a dominant allele.

Answer: C
Acceptable standard
Diff. = 0.640

14. A successful "growth factor" gene could regulate the production of

A. insulin or ADH
B. cortisol or androgens
C. thyroxine or somatotropin
D. adrenaline or noradrenaline

Numerical Response

Answer: 259
Acceptable standard
Diff. = 0.452
(Note: do not round until all calculations are complete.)

4. Assume that a population of 200 brine shrimp increases at a rate of 9.00% per day. What would be the total population of brine shrimp at the end of 3 days?

Answer: ____________
(Record your answer to three significant digits in the numerical-response section of the answer sheet.)

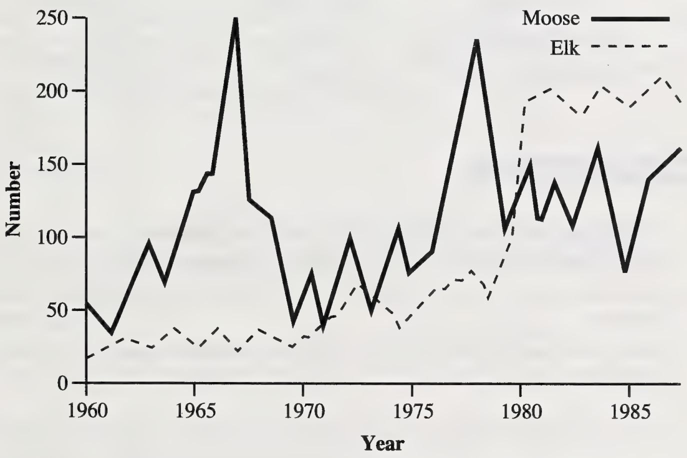
Use the following information to answer the next two questions.

A context of this length would normally be used with three or four questions.

In an attempt to manage the moose (mostly browsers) and elk (mostly grazers) populations in Elk Island National Park, wardens trapped surplus elk and shipped them out of the park but trapping moose was unsuccessful. Moose populations varied drastically. They often suffered from malnutrition because of a lack of browse (woody shoots). At high population densities, the moose had severe infestations of ticks. Ticks attach to the skin of moose and feed on blood. During severe infestations, an adult moose can have 100 000 ticks on its skin. Infected moose lose a large amount of blood and spend much of their time rubbing against trees rather than feeding. Surplus moose were hunted to reduce their numbers before they starved or suffered from tick infestations. These methods did not meet the objectives of the park and a new management plan was implemented in 1977.

The park wardens started a spring burning program that reduced the shrubby growth while increasing the amount of grass available. Natural fires were allowed to burn themselves out unless they became dangerous. The population density of the elk has been increased by reducing the number trapped and transplanted. Special fences were constructed that allow elk or moose to jump the fences and leave the park.

Number of Elk and Moose in Elk Island National Park



15. Which changes in biotic factors listed at the right caused the change in the moose population after the implementation of the new management program?

A. 1 and 2 only
B. 1 and 4 only
C. 2 and 3 only
D. 3 and 5 only

Changes in Biotic Factors

1. A decrease in browse
2. An increase in graze
3. An increase in predators
4. An increase in emigration of moose
5. A decrease in immigration of moose

Answer: B
Acceptable standard
Diff. = 0.526

Answer: C
Acceptable standard
Diff. = 0.300

16. Which statement best describes the elk and moose populations?

A. Elk are K-selected and moose are r-selected.
B. Moose are K-selected and elk are r-selected.
C. Both populations are K-selected.
D. Both populations are r-selected.

Use the following information to answer the next question.

Some students collected data in their school on various human traits that are controlled through simple inheritance. One of the traits investigated was tongue rolling. Some students could curl their tongues lengthwise (referred to as rollers) while others could not (non-rollers). The data are shown in the following chart.

School Data For Tongue-Rolling Trait

Phenotype	Number of individuals	Percent of population
Tongue rollers	832	64.0%
Non-tongue rollers	468	36.0%

Numerical Response

Answer: 624
Standard of excellence
Diff. = 0.183

5. Based on the school data, how many individuals would be expected to have a heterozygous genotype?

Answer: _______
(Record your answer to three significant digits in the numerical-response section of the answer sheet.)

Use the following information to answer the next question.

American geneticists have embarked on a twelve year, $3 billion effort to map out all the hereditary information found on human chromosomes. This human genome project, funded by the U.S. government and the National Institute of Health, has mounted a campaign to patent each DNA fragment that its researchers can reproduce.

An ambitious French geneticist, Daniel Cohen, has jumped ahead of his American rivals and is close to completing the first map of the human genome. Cohen intends to donate his gene map to the United Nations as a gift to the world, thereby ensuring all scientists unrestricted access to vital data.

The human genome contains 3.5 billion base pairs. To decipher so much material, researchers must first chop the genetic material into smaller, more manageable fragments. American scientists have been working with about 70 000 fragments, each containing 50 000 base pairs. Cohen was able to divide the genome into only 500 pieces, each containing 7 million base pairs, by genetically manipulating yeast cells to produce the pieces. Although Cohen's genetic map will need refinement, he hopes to deliver it within a few months.

It may be another 10 years before the world's scientists can consult a genetic recipe book with an accurate printout of the base-pair sequences for all 100 000 human genes. Whether scientists will be able to consult the recipe book for free or for a fee has yet to be decided.

Written Response

1. Describe two technologies that are used in the human genome project, hypothesize how the project will aid in the treatment of human disorders, and describe a societal issue that is associated with the project.

12 marks

Be sure that your response includes the following information:

- Descriptions of two technologies that are used directly in the analysis of human genetic material
- A hypothesis about the use of genome information in the treatment of disorders of the human body
- A description of a societal issue arising from the use of information collected during the genome project

The student is given the assignment and then is reminded of the requirements of the assignment. Sample answers and scoring guides follow.
Diff. = 0.500E (estimated mean score)

Scoring Criteria for the Written-Response Question

Students' responses might include some of the following information. Many other responses could be appropriate.

Technology	*Use in Human Genome Project*
Microscope	Identification of chromosomes
Restriction enzymes	Used to "cut" DNA into fragments
Ligases	Used to fuse fragments of DNA
Electrophoresis	Separation of DNA/nucleotides
Gene splicing	Use of enzymes to manipulate chromosome content
Recombinant DNA	Artificial association of DNA molecules that are not naturally found together
DNA cloning	Production of large numbers of DNA molecules required for research
Karyotyping	Identification of chromosomes
Gene/chromosome mapping	Determining loci of genes

Treatment	*Use*
Cloning	Production of body parts to be used as transplants
Gene therapy/ insertion/removal	Treatment for inherited disorders (e.g., cystic fibrosis)
Hormone treatment	Artificial production of hormones/enzymes used for treating disorders (e.g., production of HGH)

Societal Issues	*Use*
Who receives treatment?	Who selects patients?
Are any genes "off–limits" for exploitation?	Who pays for research?
Which traits are desirable?	Who can use the information collected?
What is the effect on the process of natural selection?	How will gene frequencies for traits be affected?

For an article related to this topic see Morris, Linda J., "Bioethical Dilemmas, Decision-making and the Human Genome Project," *The Science Teacher*, February, 1994, pp. 39– 41.

The following scoring guide will be used by a marker to assign a score out of four.

Score	Scoring Description
4 **Standard of Excellence**	The student's response addresses the major points of the questions. The student *describes* two relevant technologies, *provides* a viable hypothesis about treatment of human diseases, and *describes* a societal issue directly related to the manipulation of the human genome. The student's response is well organized. The student explains concepts clearly and logically, and demonstrates consistency of thought. The student uses complete sentences that make effective use of scientific vocabulary.
3	The student's response addresses most of the major points of the questions. The student *describes* one relevant technology, *identifies* a second technology, *provides* a hypothesis about treatment of human diseases, and *describes* a societal issue directly related to the manipulation of the human genome. The student's response is organized. The student explains concepts in complete sentences and consistently uses appropriate scientific vocabulary.
2 **Acceptable Standard**	The student's response addresses some of the major points of the questions. The student *describes* one relevant technology, *provides* a hypothesis related to the treatment of human disorders, and *identifies* a societal issue related to the manipulation of the human genome. The student's response demonstrates some organizational skills. The student explains concepts in complete sentences and uses some appropriate scientific vocabulary.
1	The student's response addresses few of the major points of the question. The student *identifies* one relevant technology and *provides* a hypothesis about treatment of human diseases or *identifies* a societal issue somewhat related to the manipulation of the human genome. Organizational skills are not evident. The student explains concepts but does not consistently use appropriate scientific vocabulary. More than one reading may be required to abstract the sense of the response.
0	The student's response does not address any of the major points of the question.

Each student response will be read by two markers. The scores assigned by the markers will be added together to provide a score out of eight. This score will then be used to pro-rate a score out of twelve.

Possible Scores

Marker 1 *X*/4	Marker 2 *X*/4	Marker 1 + Marker 2 *X*/8	Pro-rated Score *X*/12
4	4	8	12
4	3	7	11
3	3	6	9
2	3	5	8
2	2	4	6
2	1	3	5
1	1	2	3
1	0	1	2
0	0	0	0

Sample Answers to the Written-Response Question

Score 4 – Standard of Excellence

The two technologies used in analyzing the human genome are microscopes and computers. With a high tech scanning turelling microscope, scientists are able to magnify DNA a million time greater than the ordinary microscope used to view DNA. With this they are able to see strands of DNA and decipher its patterns and sequences. Computers, through automation, have enabled scientists to quickly scan thousands of amino acid sequences at once. This is more cheaper, efficient and faster than the "hands on" method they use to perform.

The project will aid the development of treatments for human disorders by gene therapy and recombinant DNA. Scientists will be able to find healthy DNA to replace unworkable DNA. In addition, scientists, through gene mapping can locate parts of the chromosome and which chromosome is the cause of a person's disorder. For examples, the midsection of chromosome 7 is the location of the disease called "cystic fibrosis." With knowing this they can alter, remove, or somehow fix this chromosome to make it "normal" again. As well, scientists can use bacteria to synthesize insulin by locating the gene that directs cells of the human pancreas to synthesize insulin. This bacteria injected into the person can aid in the treatment of diabetes in humans. With recombinant DNA, scientists can put in healthy cells into abnormal cells to allow production of more healthy cells.

A societal issue that is associated with the project is the fact whether people think it is morally correct. Many questions and controversial issues arise such as should man play God in the lives of their fellow people? Should we be allow to make a perfect person? Should we question fate and a person's destiny by changing the arrangement of their lives? Should we allow people to take away our privacy and view our own personal DNA and what makes us?

Score 3

Two technologies are the election microscope and biotech research. By mapping the genes and knowing exactly which genes are responsible for what human disorders we can then cure any of these disorders through abortion of babies affected by these disorders, or the genes could be cut out and not replaced (similar to gene therapy: replacement). By knowing where these genes are we can develop new ways to cure, or create genes that will replace the affected gene and cure the individual.

A societal issue would be should the genes be patented or left to be used to help all? Some believe that they should help all like Daniel Cohen. While others believed it should be used (patented) to make money and also so only the rich can afford the luxuries of making their lives better. All humanity good benefit through the gene map being used for all not only who could afford it. Humanity would still be differs yet stronger since these dangerous disorders that cause eventually death are gone. When used for all more cures and ways could be found to help and develop more treatments or cures to benefit are not the few. In the long run it's better if all can have access to it and more advancements will be made and everyone will benefit.

Score 2 – Acceptable Standard

Gene mapping is a technology used to map out the human genome. Geneticists have learned many things by mapping out the genes.

But perhaps an even greater technology is genetic engineering. We are able to produce bigger and better organisms for our use. Not only can new things be created but new information can be found about our genes. The human pancreas synthesizes insulin and the gene an be transplanted into bacteria. The bacteria is also then able to be synthesize insulin. The insulin can be used to treat diabetes in humans. There are many possible reasons why we should allow genetic engineering in society today but there are also negative aspects.

Many religious groups feed that we should not "fool around" with God's already perfect organisms. There are many people who believe everything should be left the way it is.

Cloning is another technology that can be used as an example of analyzing the human genome. Should we be able to make duplicates of organisms, etc. This is also a political problem. The government believes cloning is not right and therefore it is not legal. But how will we discover new things and gain more knowledge on our genomes without being able to perform genetic engineering or even cloning.

For many aspects, these two technologies can be seen as wrong or right but how else will we find treatments for human disorders? The more knowledge we have, maybe the more lives will be helped or even saved.

Score 1

A microscope may be used to analyze the human chromosome. Studying the chromosomes will help researchers to learn more about diseases. By studying a disease one can find out what is causing it, or what is lacking in the body or what is needed. And a microscope is a benefit in studying this. Social problems could arise from using the microscope to study chromosomes, such as if a researcher found out about a disease that was in the body and the person had not yet known about it.

A problem of the person not wanting to know what was or could happen to him/her in the future even though the researcher has found out about it.

Other social problems could be people wanting to know more about the project and scientists not being able to give this. Scientists have to practice observations over and over. Someone might not want to wait for more research because they don't have time. This could cause a big social issue.

The structure ladder that Watson and Crick invented could be used to study chromosomes also. This helps one understand DNA structures more clearly and one can have a hands-on structure to use. Now one can have the real thing in front of them instead of having a picture in their head.

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Background

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technological developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diploma examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writing diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of information that can be stored in calculators that are brought into diploma examinations.

2. Students must clear calculators that are brought into diploma examinations of all information previously stored except for
    a. programs used for computing values of the formulas that are provided on the diploma examination tear-out pages or in a separate data booklet for the subject being written,
    b. programs used for Quadratic Relations as found in the Mathematics 30/33 Interim Teacher Resource Manual.

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlining operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
    a. all calculators operate in silent mode,
    b. students do not share calculators or information contained within them,
    c. calculator cases are stored on the floor throughout the exam, and
    d. all examination rules are followed.

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science Unit, Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

Revised 19 September 94

Examination Rules

GRADE 12 DIPLOMA EXAMINATIONS

1. **Admittance to the Examination Room**
   Students must not enter or leave the examination room without the consent of the supervising teacher.

2. **Student Identification**
   Students must present identification that includes their signature and photograph. One of the following documents is acceptable: driver's licence, passport, or student identification card. Students must not write an examination under a false identity or knowingly provide false information on an application form.

3. **Identification on Examinations**
   Students must not write their names or the name of their school anywhere in or on the examination booklet other than on the back cover.

4. **Time**
   Students must write an examination during the specified time and may not hand in a paper until at least one hour of the examination time has elapsed. Students who arrive more than one hour after an examination has started will not be allowed to write the examination. Students who arrive late but within the first hour of an examination sitting may be allowed to write only at the discretion of the supervising teacher.

5. **Discussion**
   Students must not discuss the examination with the supervising teacher unless the examination booklet is incomplete or illegible. Students must not talk, whisper, or exchange signs with one another.

6. **Answer Sheets**
   Students must use an HB pencil to record their answers on the machine-scorable answer sheets.

7. **Written Responses**
   All work for the written-response sections of the diploma examinations must be done in the examination booklet. Students are expected to write their revised work in blue or black ink for English 30, English 33, Français 30, and Social Studies 30.

8. **Material Exchanges**
   Students must not copy from other students or exchange material. Notes in any form—including those on papers, in books, or stored in electronic devices—must not be brought into the examination room. Calculator programs designed to perform mathematical computations or those designed to assist students in graphing are not classified as notes (see *Calculator Policy*).

9. **Materials Allowed**
   English 30, English 33: Students may use a dictionary and a thesaurus for Part A only. Electronic devices are not allowed for either part.
   Français 30: Students may use a dictionary, a thesaurus, and a book of verb forms for Partie A only. Electronic devices are not allowed for either part.
   Social Studies 30: Students may not use electronic devices.
   Biology 30, Mathematics 30, Physics 30: Tear-out data pages are provided in the examination booklet. Students need to use scientific calculators (see *Calculator Policy*) but must not share them.
   Chemistry 30, Science 30 (Pilot): A separate data booklet is provided for each of these examinations. Students need to use scientific calculators (see *Calculator Policy*) but must not share them.

   Students are expected to provide their own writing materials, including pens and HB pencils, calculators, or other necessary instruments. Tear-out pages for rough work are provided in each biology, chemistry, mathematics, physics and science (pilot) examination booklet.

10. **Translation Dictionaries**
    Students are not allowed to use translation dictionaries in any subject. Exchange students must satisfy the same requirements as other students.

Revised 19 September 1994

Appendix C

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics and Sciences Diploma Examinations

Significant Digits

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   $$\begin{array}{r l} 12.3 & \text{(least precise)} \\ 0.12 & \\ \underline{12.34} & \\ 24.76 & \end{array}$$

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   (1.23)(54.321) = 66.81483

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits. For example:

   In determining the value of (1.23)(4.321)/(3.45 – 3.21), three calculations are required:

   a. 3.45 – 3.21 = 0.24

   b. (1.23)(4.321) = 5.31483

   c. 5.31483/0.24 = 22.145125

   [Not 5.31/0.24 = 22.125]

   The value should be rounded to 22.1.

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix D

Explanations of Cognitive Levels

Knowledge refers to those behaviours and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material, or phenomena.

Comprehension refers to responses that demonstrate an understanding of the literal message contained in a communication.

Application requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypothesis, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize a writer's viewpoint.

Synthesis is the production of a unique communication. It is the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

Evaluation is defined as making judgements about the value of ideas, solutions, and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical, or satisfying. Evaluation includes the ability to apply given criteria to judgements of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

Directing Words

Discuss

The word "discuss" will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity.

The following words are specific in meaning. The corresponding cognitive levels are enclosed in parentheses.

Contrast/Distinguish

Point out the *differences* between two things that have similar or comparable natures. (Analysis)

Compare

Show the character or relative values of two things by pointing out their *similarities* and *differences*. (Analysis and/or Evaluation)

Conclude

State a logical end based on reasoning and/or evidence. (Evaluation)

Criticize

Point out the *merits* and *demerits* of an item or issue. (Analysis and Evaluation)

Define

Provide the essential qualities or meaning of a word or concept. Make distinct and clear by marking out the limits. (Knowledge)

Describe

Give a written account of or represent the characteristics by a figure, model, or picture. (Knowledge)

Design/Plan
Construct a plan, i.e., a detailed sequence of actions, for a specific purpose. (Application and/or Synthesis)

Enumerate
Specify one by one or list in concise form and according to some order. (Knowledge)

Evaluate
Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages. (Analysis and Evaluation)

Explain
Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail. (Comprehension)

How
Show in what manner or way, with what meaning. (Comprehension)

Hypothesize
Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically. (Analysis and Synthesis)

Identify
Recognize and select as having characteristics of. (Knowledge)

Illustrate
Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram. (Comprehension and/or Application)

Infer
Form a generalization from sample data; arrive at a conclusion by reasoning from evidence. (Evaluation)

Interpret
Tell the meaning of; present information in a new form that adds meaning to the original data. (Comprehension)

Justify/Show How
Show reasons for or give facts that support a position. (Evaluation)

Outline
Give, in an organized fashion, the essential parts of. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps. (Knowledge and/or Comprehension)

Predict
Tell in advance on the basis of empirical evidence and/or logic. (Application)

Prove
Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons. (Evaluation)

Relate
Show logical or causal connection between. (Analysis)

Solve
Give a solution for a problem, i.e., explanation in words and/or numbers. (Analysis and Synthesis)

Summarize
Give a brief account of the main points. (Comprehension)

Trace
Give a step-by-step description of the development. (Knowledge)

Why
Show the cause, reason, or purpose. (Comprehension and/or Synthesis)

Appendix E

Preparing to Write a Science Diploma Examination—What every student should do before the examinations!

1. Prepare a course review schedule:
   - design your schedule for the two-week period (minimum) before the examination
   - divide the course material into sections and indicate on the schedule the time blocks to be devoted to each section
     - take into account the examination blueprint available from your teacher (*Diploma Examinations Program Information Bulletin* for the course). Note that course units are not equally weighted on the diploma examination
     - take into account units/concepts that you find most difficult; i.e., allocate more time for the review of these

2. Obtain and review examination schedules, rules, and policies:
   - record the time and place of writing
   - note minimum and maximum writing times permitted
   - prepare to remain in the examination room for at least 2.5 h (Kleenex, cough drops, etc.)
   - identify materials allowed for writing each examination, such as pencils, pens, calculators, mathematical instruments, and clear plastic ruler

3. Identify and collect examples of each type of question that will be asked:
   - obtain a copy of the relevant information contained in the *Diploma Examinations Program Information Bulletin* for the course (available from your teacher)
   - review the format of previous diploma examinations (available from your teacher)
   - learn the meanings of key "directing" words such as compare, describe, evaluate, explain, illustrate, interpret, justify, prove, and solve

4. Make summaries and point form outlines:
   - distinguish between major concepts and factual details
   - identify essential skills that can be assessed on paper and pencil tests
   - review lab results and procedures—identify connections between lab reports, class notes, and textbook
   - anticipate examples of connections between concepts and the "real world"
   - prepare a glossary of important subject terminology
   - review the data booklet for Chemistry 30 or Physics 30, and review formulas and equations if applicable
   - link each formula or equation with a calculation done on a previous test or assignment
   - identify any restriction on the use of each formula or equation

5. Use memory aids such as:
   - colour coding, underlining, highlighting, jotting keywords in margins
   - numbering points to be memorized
   - grouping word and idea associations
   - reading aloud key words, expressing key words in your own words

6. Review the different question formats and the instructions on how to answer these questions.

Appendix F

Suggestions for Students When Writing Science Diploma Examinations—What every student should know when writing examinations!

1. Do not be afraid to answer each question even if you are not sure of the correct solution to the problem. A penalty is NOT given for guessing on the machine-scored section the exam. Partial marks are often awarded for incomplete answers in the written-response section of the exam.

2. If you are stuck on a question, mark the alternatives that you know are incorrect and choose from the ones that are left using logical guessing strategy. Think of the questions as challenges and cultivate a positive attitude about your ability to answer them.

3. Scan the sets of questions of the examination before answering a particular question. The questions in one set of the examination may jog your memory about a question in another set.

4. When first reading a multiple-choice question, locate and circle key words to help clarify the meaning of the question. Then hide the alternatives and try to formulate an answer of your own. Your answer may be very close to the correct alternative.

5. If a multiple-choice question involves a calculation, do the calculation and select the alternative that is closest to your answer. A multiple-choice calculation is usually short. If you cannot do it in five minutes, your method is either inappropriate or incorrect. Go on.

6. Diagrams on examinations are often labelled with numbers or letters. It may be useful to write in the names of the labelled structures or features that you can identify.

7. When reading graphs, use a clear plastic ruler to more accurately extrapolate or interpolate data.

8. Have a good reason for changing an answer. Do not change an answer on a hunch. Do not waste your time looking for patterns of As, Bs, Cs, or Ds in multiple-choice answers. There are none.

9. You may not have time to write and edit a complete rough copy for each written-response question, but you should prepare an outline of your answer and use it as a guide when writing your good copy.

10. When completing a written-response question, keep in mind the reader of your response. The reader will want to know how well you:
    - understand the problem or the mathematical/science concept
    - can correctly use the mathematics involved
    - can use problem-solving strategies and explain your answer and procedures
    - can communicate your solutions and mathematical/science ideas

11. Rewriting a statement of the question is often a good way to begin a written response. Conclude with a summary statement. Be sure you have clearly explained all assumptions and have verified your conclusions.

12. Keep track of the time and pace yourself. Put a check mark by items that you are uncertain about and return to them if there is time at the end of the examination.

Appendix G

Specific Prerequisite Concepts And Skills For Biology 30

Biology 30 Concepts

1.1.1 The human organism regulates physiological processes using electrochemical control *systems*.
1.1.2 The human organism maintains homeostasis through the use of complex chemical control *systems*.
2.2.1 Humans and other organisms have complex reproductive *systems* that ensure the survival of the species.
2.2.2 Reproductive success of organisms is regulated by chemical control *systems*.
3.2.3 Cell differentiation and organism development are regulated by a combination of genetic, endocrine, and environmental influences.
4.3.1 Cells divide to increase in number but must reduce their chromosome number before combining at fertilization.
4.3.2 Genetic characters are handed down by simple rules.
5.3.3 Classical genetics can be explained at a molecular level.
6.4.1 Communities are made up of populations that consist of pools of genes from the individuals of a species.
6.4.2 Individuals of populations interact with each other and members of other populations.
6.4.3 Population *change* over time can be expressed in quantitative terms.

Specific Prerequisite Concepts

Prerequisite Concept	**Biology 30 Concept**										
	1.1.1	1.1.2	2.2.1	2.2.2	3.2.3	4.3.1	4.3.2	5.3.3	6.4.1	6.4.2	6.4.3
• eukaryote cell: structure and function of organelles	√		√		√	√	√				
• cell membrane: structure, passive and active transport mechanisms	√	√		√	√	√					
• chemistry: basic vocabulary—atom, ion, electron, proton, neutron, molecule, compound, inorganic, organic, reactant, product, solute, solvent, acid, base, catalyst	√	√		√	√			√			
• cellular enzymes: factors that affect activity; e.g., concentration, temperature, pH	√	√		√	√	√		√			

Prerequisite Concept	Biology 30 Concept										
	1.1.1	1.1.2	2.2.1	2.2.2	3.2.3	4.3.1	4.3.2	5.3.3	6.4.1	6.4.2	6.4.3
• cellular respiration: role of oxygen, glucose, and ATP in providing energy	√	√	√	√	√	√					
• human body: general morphology	√	√	√	√	√						
• digestive system: morphology, digestion, absorption, storage		√									
• classification of nutrients: minerals, vitamins, carbohydrates, lipids, proteins		√									
• kidney: nephron structure and basic function (formation of hypertonic urine)		√									
• circulatory system: blood composition, vessel and heart structure and function	√	√		√	√						
• chromosomes: contain genetic information			√			√	√	√			
• pathogens: viruses, bacteria	√	√	√							√	
• animals and plants: general knowledge of major groupings; e.g., invertebrates and vertebrates, non-vascular and vascular plants			√			√	√		√	√	√
• relationship of molecular structure and function	√	√		√				√			
• ecology: basic vocabulary—population, species, community, ecosystem, biome, biotic and abiotic factors, habitat, niche, adaptation									√	√	√

Specific Prerequisite Skills

Prerequisite Skill	Biology 30 Concept										
	1.1.1	1.1.2	2.2.1	2.2.2	3.2.3	4.3.1	4.3.2	5.3.3	6.4.1	6.4.2	6.4.3
• use a light microscope to examine prepared microscope slides	√	√	√		√	√	√				
• prepare microscope slides of fresh materials						√					
• use dissecting instruments	√				√	√					
• design simple controlled investigations	√						√				
• construct and interpret line, bar, and circle graphs and scatter plots	√	√		√	√		√		√		√
• construct and use "line of best fit"	√	√		√	√		√	√	√		√
• extrapolate and interpolate data	√	√		√			√		√		√
• use mathematical calculations to express relationships and probabilities as fractions, percentages, and proportions							√		√		√
• use algebraic expressions and equations to represent relationships							√		√		√
• understand exponents, scientific notation, and significant digits							√		√		√
• solve linear and quadratic equations							√		√		√

Appendix H

STS Connections, General Learner Expectations, and Enablers for Item Writing

Context and Assessment

In structuring questions for assessment, it is important to present the task required in a context that is meaningful to students and pertinent to the discipline. Where possible, the context for such questions must be analogous to those situations that adults and professionals in the discipline would face. They are non-routine, real problems that require several steps in their solution. In order to deal with the complexity of tasks and the cultural-societal implications, it is important that the stems of the questions contain the necessary contextual clues. Details within the questions need to be sufficient to ensure that students have a clear sense of what kind of answers fit the problems at hand.

An example of contextual questions in the field of human physiology can be found in many of the examinations that are used to assess medical students. Students are given a situation (context) and must provide a detailed analysis of the situation and recommend alternative solutions. The solutions are assessed with respect to the thoroughness and accuracy of the analysis, the implications with respect to the individual patient, and the validity and practicality of alternative solutions. A second example of contextual situations can be found in environmental impact assessments. Environmentalists are required to analyze and determine the factors acting upon a situation and then to present viable alternatives with respect to a conclusion.

We can assess the responses of students in many different formats. Specific details can be asked for through the use of several multiple-choice questions that relate to a context. Short answers to specific questions may also be valid for this situation, or students could be asked to structure a more detailed written-response answer. The problems must be engaging, non-routine, and require quality responses.

The assessment tasks should enable us to assess students' understandings of the discipline, their ability to relate the discipline to technological situations, or their judgement with respect to applicable societal issues. Students must accurately and willingly provide clear and forthright communication. They must demonstrate deep understanding of biological concepts in their solutions to real-life problems.

Biology 30 Concepts and STS Connections

1.1.1 The human organism regulates physiological processes using electrochemical control *systems*.

- a. The use of chemicals to alter the function of the nervous system; e.g., anesthetics, prescription and non-prescription drugs, environmental chemicals.
- b. Biological basis of neurological diseases; e.g., Alzheimer's, Parkinson's.
- c. The use of technology to extend sensory limits; e.g., lenses, hearing aids.
- d. Development of biological offensive and defensive military capabilities.
- e. The use of technology to extend longevity and improve quality of life; e.g., electrical control of limbs, pacemakers.
- f. The impact of photoperiod and light wavelength and duration on the human organism.

1.1.2 The human organism maintains homeostasis through the use of complex chemical control *systems*.

- a. The use of biotechnology to solve hormone problems; e.g., diabetes, dwarfism, milk production.
- b. The use of hormones in the treatment of aging, body building.

c. Relationships of atmospheric changes, light, and skin function; i.e., synthesis of vitamin D, formation of pigment, skin cancer.

2.2.1 Humans and other organisms have complex reproductive *systems* that ensure the survival of the species.

a. The use of reproductive technology.

b. Problems created by sexually transmitted diseases.

2.2.2 Reproductive success of organisms is regulated by chemical control *systems*.

a. The use of hormones for altering reproductive processes and their effects on humans.

b. The effect of aging on reproductive hormone homeostasis.

3.2.3 Cell differentiation and organism development are regulated by a combination of genetic, endocrine, and environmental influences.

a. The use of technology to solve problems of incompatibility between fetus and mother.

b. The impact on society of knowledge of fetal development.

c. The impact on society of fetal syndromes caused by prenatal ingestion of drugs; e.g., alcohol, cocaine.

d. The impact of birth control technologies on population demographics, both in developing and developed countries.

4.3.1 Cells divide to increase in number but must reduce their chromosome number before combining at fertilization.

a. The use of biotechnology in regenerating damaged or missing parts of organisms.

b. The prevention and treatment of cancer in plants and animals.

c. The impact on society of knowledge of mitosis and meiosis.

4.3.2 Genetic characters are handed down by simple rules.

a. The role of genetic counseling in the treatment of potentially disabling genetic disorders.

b. The role of gene banks in preserving endangered species and genotypes, particularly of plants and animals used in agriculture.

c. The use of biotechnology and gene replacement therapy in the treatment of human genetic disorders.

d. The impact of the Human Genome Project on society.

5.3.3 Classical genetics can be explained at a molecular level.

a. The use of genetically engineered organisms in agriculture, forestry, and bioremediation in the natural environment.

b. The definition of life.

c. The potential risks of genetic engineering to life on Earth.

d. The implications to society of patenting new life forms produced by biotechnology.

e. The impact of DNA mapping technology on the study of genetic relationships and variations.

6.4.1 Communities are made up of populations that consist of pools of genes from the individuals of a species.

a. The implications of introducing exotic species into an ecosystem where natural predators do not exist.

b. The role of ecological reserves in preserving our natural heritage.

c. The role of models in science to explain observable phenomena; e.g., the Hardy-Weinberg principle.

6.4.2 Individuals of populations interact with each other and members of other populations.

a. The implications of the predator-prey relationship for wildlife management in national and provincial parks.

b. The long-term implications of ecosystem fire control and prevention on population and ecosystem stability and diversity.

c. The relationship between parasites and human developmental potential in developing countries.

6.4.3 Population *change* over time can be expressed in quantitative terms.

a. The growth of human populations and a comparison of them with the naturally occurring populations of other species.

b. The implications for natural systems inherent in the chaos theory.

c. The development of investigative strategies for dealing with biological problems; i.e., risk-benefit analysis, cost-benefit analysis.

GLE (Knowledge) 1

The student can show that humans use nervous and endocrine systems to maintain internal equilibrium among their systems while simultaneously interacting and maintaining equilibrium with the external environment.

SYSTEMS REGULATING CHANGE IN HUMAN ORGANISMS (UNIT 1)

Concept 1.1.1 The human organism regulates physiological processes, using electrochemical control *systems*.

	Acceptable Standard	*Standard of Excellence*
The structure of a neuron, the formation of an action potential and the transmission of a signal across a synapse or neuromuscular junction	The student can • identify the cell body, axon, dendrite, Schwann cell, myelin sheath, nodes of Ranvier, synaptic knob, and neurilemma using prepared slides, photomicrographs, or diagrams of neurons • describe a synapse and a neuromuscular junction • compare the structure and function of sensory neurons, motor neurons, and interneurons (association neurons) • define action potential and refractory period • describe how a signal is transmitted across a synapse or neuromuscular junction using acetylcholine • describe the role of cholinesterase in regulating synaptic transmission • recognize that there are many other chemical transmitters including norepinephrine (noradrenaline)	The student can • explain how action potentials develop • explain the role of sodium/potassium pumps and ion channels in the establishment of resting potentials • relate types of stimuli, threshold levels, and the all-or-none response to action potentials • relate the function of myelin sheaths to impulse transmission • recognize that chemical transmitters may be excitatory and/or inhibitory in nature • explain how humans can experience a range in intensity of stimuli because of changes in the frequency of impulses
The structures of the central and peripheral nervous systems and their functions in regulating the voluntary and involuntary systems of the human organism	The student can • identify the cerebrum, lobes of the cerebrum, hemispheres of the cerebrum, cerebellum, hypothalamus, pons, and medulla oblongata, using models, computer simulations, dissected mammalian brains, or diagrams • identify the functions of the cerebrum, lobes of the cerebrum, hemispheres of the cerebrum, cerebellum, hypothalamus, pons, and medulla oblongata • relate the location of myelinated and unmyelinated nerve fibres to white and gray matter within the central nervous system • trace the pathway of a reflex arc to and from the spinal cord • describe the organization of the peripheral nervous system in terms of sensory, motor, somatic, autonomic, sympathetic, and parasympathetic pathways • identify the functions of the autonomic nervous system	The student can • design and perform an experiment to investigate a reflex arc • explain the homeostatic function of the autonomic nervous system

	Acceptable Standard	*Standard of Excellence*
The systems (organs) that allow humans to sense their environment and their spatial orientation	The student can • identify structures responsible for detecting external stimuli (mechanical, chemical, heat, sound, and light) • identify the major structures of the eye including the cornea, lens, iris, pupil, aqueous and vitreous humors, retina, fovea centralis, blind spot, choroid layer, sclera, optic nerve, rods, and cones • explain how the structures of the eye are used to form retinal images of the external environment • explain how technology can be used to correct vision defects such as nearsightedness, farsightedness, astigmatism, and cataracts • identify the major structures of the ear including the outer, middle, and inner ear, auditory canal, eustachian tube, eardrum (tympanic membrane), ossicles, semicircular canals, utricle, saccule, the fluid-filled cochlea, organ of Corti, basilar membrane, round window, oval window, and auditory nerve • describe receptors involved in senses such as taste, smell, touch, pressure, pain, and temperature change	The student can • illustrate the chemistry of vision by using rhodopsin as the example • explain how structures of the ear initiate impulses that stimulate auditory and balance centres in the brain • compare the roles of the eye and ear in spatial orientation

Concept 1.1.2 The human organism maintains homeostasis through the use of complex chemical control *systems*.

	Acceptable Standard	*Standard of Excellence*
The endocrine glands, the hormones they produce, and the metabolic roles of those hormones	The student can • contrast exocrine and endocrine glands in terms of their structure and function • identify the main endocrine glands in diagrams and models, e.g., pituitary, thyroid, adrenals, and pancreas islet cells • identify the main hormones produced by the above endocrine glands including thyroid stimulating hormone, somatotropin (human growth hormone), antidiuretic hormone, adrenocorticotropic hormone (ACTH), thyroxine, epinephrine (adrenaline), norepinephrine (noradrenaline), aldosterone, cortisol, insulin, and glucagon • summarize the functions of the above hormones	
The endocrine system allows humans to sense their internal environment and respond to it appropriately	The student can • describe how internal stimuli activate glands causing the release of specific hormones • relate the connection between a hormone and its target cells in terms of a physiological effect	The student can • infer, through the analysis and interpretation of data, the role of a hormone in regulating the internal environment • describe the action of polypeptide and steroid hormones in cells
The endocrine and neural control systems act together	The student can • compare the nervous system and the endocrine system in terms of their respective roles in maintaining homeostasis • contrast the mode of transmission, duration of effect, and reaction time of the nervous system and the endocrine system • describe the interaction between the hypothalamus and pituitary • illustrate how the adrenal glands and the autonomic nervous system interact in times of stress • relate physiological consequences of hyposecretion and hypersecretion of some hormones	The student can • compare complementary effects, and the involvement in negative feedback loops, of the nervous system and the endocrine system • design an experiment to investigate evidence of a hormonal disorder such as diabetes mellitus

GLE (Knowledge) 2

The student can show that humans and other organisms have chemically regulated reproductive systems, which ensure survival of the species, and can describe how sexually transmitted diseases interfere with human reproductive function.

REPRODUCTION AND DEVELOPMENT (UNIT 2)

Concept 2.2.1 Humans and other organisms have complex reproductive *systems* that ensure the survival of the species.

	Acceptable Standard	*Standard of Excellence*
Determination of gender in the fetus	The student can • identify the chromosome composition of the zygote that determines the gonad development in the fetus • recognize that androgens and estrogens in the fetus determine sex characteristics	
Male and female reproductive organs	The student can • describe the function of the seminiferous tubule, epididymis, vas deferens, and urethra in the production and delivery of sperm • describe the function of the seminal vesicle, prostate, and Cowper's gland in the formation of seminal fluid • describe the function of the ovarian follicle and Fallopian tube in the production and delivery of eggs • describe the structure and function of the vagina and uterus • identify male and female reproductive organs in diagrams and models • identify sperm, eggs, and supporting structures, using diagrams or prepared slides of testes and ovaries • compare the structure and function of sperm and egg • describe the composition of semen	
Sexually transmitted diseases	The student can • illustrate, using one specific example, how a sexually transmitted disease may damage the reproductive system	

Concept 2.2.2 Reproductive success of organisms is regulated by chemical control *systems*.

	Acceptable Standard	*Standard of Excellence*
Hormone regulation of primary and secondary sex characteristics	The student can • define primary and secondary sex characteristics • identify the role of hormones related to reproduction, e.g., testosterone, estrogen, progesterone, FSH, LH • illustrate how gender differences reflect a continuous range of characteristics rather than discrete gender categories • illustrate, using a male or female reproductive hormone, how intake from external sources can be used in medical treatment	The student can • explain how the hypothalamus, anterior pituitary, and testis provide negative feedback regulation of the maturation of male and female sex characteristics • compare hormone regulatory mechanisms in male and female reproductive systems
Male periodic and continuous reproductive functions	The student can • describe how nerve and hormone regulation interact to prepare the male for transmission of sperm	The student can • illustrate that regulation of sexual behavior may be influenced by environmental factors; i.e., photoperiod, temperature
Menstrual cycle	The student can • define menstruation and menopause • explain the function of menstruation and menopause in the life cycle • summarize the ovarian and uterine structural cycles • describe how hormones secreted by the follicle and corpus luteum regulate development of the endometrium	The student can • relate changing blood hormone levels to physiological events occurring in the ovary and uterus • evaluate the use of estrogen and progesterone treatments for altering normal reproductive cycles • illustrate that menstruation is limited to the females of only a few animal species

GLE (Knowledge) 3

The student can show that cell differentiation and organism development are regulated by genetic and environmental factors and that natural processes can be changed by using reproductive technologies.

Concept 3.2.3 Cell differentiation and organism development are regulated by a combination of genetic, endocrine, and environmental influences.

	Acceptable Standard	*Standard of Excellence*
Fertilization, implantation, and extra-embryonic membrane development in humans	The student can • trace the process of internal fertilization • compare the functions of the Fallopian tube, uterus, and vagina in the process of fertilization • explain how the endometrium supports implantation and development of an embryo • explain how the extraembryonic membranes in conjunction with the endometrium form the placenta • compare the function of the placenta to lungs, small intestine, and kidneys	The student can • explain how hormones secreted by the pituitary (FSH, LH, prolactin, oxytocin), ovary (estrogen, progesterone), and placenta (HCG, estrogen, progesterone, relaxin) regulate development of the endometrium and placenta
Embryonic/fetal development, parturition, and lactation in humans	The student can • summarize the physical development that occurs in each trimester of fetal development • describe how parturition is initiated by changes in hormone levels • trace the uterine changes that promote parturition • describe the structure of a mature mammary gland	The student can • describe how the germ layers (ectoderm, mesoderm, endoderm) develop from the blastocyst by gastrulation • explain how hormones and physical stimulation interact to initiate lactation
Reproductive technologies	The student can • summarize several birth control technologies • describe the process of *in vitro* fertilization	The student can • outline the procedures of amniocentesis, chorionic villus sampling (CVS), and ultrasound, and explain their uses

GLE (Knowledge) 4

The student can show that cell division in vascular plants and animals promotes growth, genetic continuity, and diversity of organisms; and that genetic traits are inherited and expressed in predictable ways if chromosome segregation, assortment, and crossing over are taken into account.

CELLS, CHROMOSOMES, AND DNA (UNIT 3)

Concept 4.3.1 Cells divide to increase in number but must reduce their chromosome number before combining at fertilization.

	Acceptable Standard	*Standard of Excellence*
The events of the cell cycle	The student can • outline the stages of the cell cycle and illustrate where, when, and why mitosis occurs in organisms • explain that a chromosome consists of sequences of genes • identify, using microscope slides, pictures, and/or diagrams, major events in the stages of mitosis and trace the events involved in maintaining a consistent complement of homologous chromosomes • describe the role of mitosis in the formation of identical twins and distinguish between identical and fraternal twins	The student can • describe factors that control, initiate, or inhibit the process of mitosis
The reduction of chromosome number in meiosis, the necessity for reduction division, and the process of crossing over	The student can • compare the number and type of chromosomes in haploid (monoploid) gametes to those in diploid cells • distinguish somatic cells from sex cells • explain the importance of chromosome number as a species characteristic • describe the necessity for reduction division before fertilization (recombination) • trace the changes in chromosome number during DNA replication, the first mitotic division, and the second mitotic division of meiosis • compare spermatogenesis and oogenesis by describing the numbers and types of gametes produced during human gametogenesis • explain how fertilization restores the diploid chromosome number • distinguish between a chromosome and a chromatid • identify normal and abnormal human karyotypes	The student can • illustrate and describe the process of crossing over and evaluate its effect on the genetic makeup of an organism • describe how non-disjunction results in trisomy or monosomy which causes disorders such as Down syndrome, Turner syndrome, and Klinefelter syndrome

	Acceptable Standard	*Standard of Excellence*
The processes of mitosis and meiosis	The student can • contrast the processes and purposes of mitosis and meiosis • compare the number and type of cells produced during mitosis and meiosis • compare the chromosome content of cells produced during mitosis and meiosis	
Alternation of generations in a range of vascular plants and animals	The student can • distinguish between asexual reproduction and sexual reproduction	The student can • compare reproductive tactics such as budding, binary fission, spore production, self-fertilization, cross-fertilization, and seed production • distinguish gametophytes from sporophytes

Concept 4.3.2 Genetic characters are handed down by simple rules.

	Acceptable Standard	*Standard of Excellence*
Evidence for the segregation of genes during meiosis and the independent assortment of genes on different chromosomes	The student can • distinguish hereditary characteristics from acquired characteristics • distinguish between genes and alleles • describe the composition and organization of a chromosome • explain how genotype influences phenotype • describe how the environment may affect the expression of genes • translate phenotypes to appropriate genotype symbols • explain the difference between homozygous and heterozygous organisms • illustrate the results of monohybrid and dihybrid crosses using Punnett squares • summarize the chromosomal theory of inheritance • determine the relationships between alleles (dominant-recessive, co-dominant or incompletely dominant, lethal, sex-linked, sex-influenced, or multiple alleles) by observing phenotype and genotype ratios • predict the results of crosses between parents of known genotype and provide phenotype and genotype ratios using Punnett squares, the rule of independent events, and the product rule • express probabilities as fractions and percentages • illustrate and interpret data using pedigree charts	The student can • interpolate the genotypes or phenotypes of parents by observing genotype and phenotype ratios of offspring • describe the genetic basis for procedures such as selective breeding, embryo transplants, and genetic screening • illustrate the four principles (laws) of Mendelian genetics using Punnett squares
The influence of crossing over on the assortment of genes on the same chromosome	The student can • describe linked genes	The student can • interpret recombination frequencies and construct simple gene maps • explain the effect of crossing over on phenotype ratios in a population
The significance of sex chromosomes compared to autosomes	The student can • distinguish a sex chromosome from an autosome • explain that sex is determined by the presence of sex chromosomes • describe the pattern of inheritance of sex-linked traits	The student can • interpret data to determine if an allele is sex-linked

GLE (Knowledge) 5

The student can show that genetic information stored in DNA molecules directs the functions of organisms and that biotechnology can be used to influence genetic expression.

Concept 5.3.3 Classical genetics can be explained at a molecular level.

	Acceptable Standard	*Standard of Excellence*
Genetic information is stored in DNA molecules and DNA molecules replicate	The student can • explain that genes are composed of DNA which contains specific sequences of base pairs • describe the molecular structure of DNA and outline the function of deoxyribose sugar, phosphate, adenine, thymine, guanine, and cytosine • explain how, when, and why DNA replicates	
Transcription and protein synthesis	The student can • describe the molecular structure and function of an enzyme • explain the "one gene - one enzyme" hypothesis • describe the molecular structure of RNA and outline the function of ribose sugar, phosphate, adenine, uracil, guanine, and cytosine • distinguish between messenger RNA and transfer RNA	The student can • trace the steps in transcription and explain the functions of codons, anticodons, initiator codons, and terminator codons • summarize the events that occur during translation • explain the significance of amino acid sequences within proteins
Changes in the structure of DNA affect individuals and species	The student can • illustrate how a change in the sequence of base pairs in DNA can change the function of genes • describe the function of restriction and ligase enzymes • describe the effect of mutations on cells and organisms	The student can • compare the functions of structural genes, regulator genes, and oncogenes • describe how cells may be transformed by inserting new DNA sequences into their genomes • analyze and infer the relationship between human activities and changes in genetic information that lead to inheritable mutations and cancer
Information in nucleic acids gives evidence for the relationships between organisms of different species		The student can • explain why similarities in genome indicate common ancestry • describe how differences in genomes of similar organisms originated • explain the use of mitochondrial DNA in establishing relationships among organisms

GLE (Knowledge) 6

The student can show that gene frequencies within populations determine the composition of communities and that these gene frequencies may reach equilibrium or continue to change over time as populations interact.

CHANGE IN POPULATIONS AND COMMUNITIES (UNIT 4)

Concept 6.4.1 Communities are made up of populations that consist of pools of genes from the individuals of a species.

	Acceptable Standard	*Standard of Excellence*
The significance of the Hardy-Weinburg equilibrium and the significance of non-equilibrium values	The student can • state the Hardy-Weinburg principle • define equilibrium and non-equilibrium values • interpret the term "genetic equilibrium" • list and analyze the five required assumptions of the Hardy-Weinburg principle • outline the mathematical equation depicting the Hardy-Weinburg principle and state the specific conditions for which it was designed • demonstrate, mathematically, the ability to solve problems using the Hardy-Weinburg equation and interpret the results	The student can • illustrate that the Hardy-Weinburg principle is based on probability • compare the evolution of a population with the Hardy-Weinburg genetic equilibrium • apply the Hardy-Weinburg principle by performing experiments and simulations to demonstrate an understanding of the concept • devise an experiment or simulation (model) to illustrate population change using the Hardy-Weinburg principle
The molecular basis and significance of gene pool change over time	The student can • define the term "gene pool" • recognize that evolution results from a change in allele frequencies within gene pools • demonstrate how gene frequency within a population either conforms to or rejects the Hardy-Weinburg principle	The student can • make predictions about populations that are not evolving • explain what could happen to a population if there is no change in the gene pool over time or if there is a change in the gene pool over time (evolution, speciation) • illustrate that gene pool change over time can be directed by natural selection resulting in evolution of the population

Concept 6.4.2 Individuals of populations interact with each other and members of other populations.

	Acceptable Standard	*Standard of Excellence*
Symbiotic relationships and competition	The student can • define commensalism, mutualism, and parasitism • compare the niche of parasitism to mutualism and commensalism • illustrate how parasites regulate population growth • analyze the symbiotic relationships in a given community • analyze the relationships between parasites and the human population potential • evaluate the symbiotic relationship between a parasite and a host	The student can • explain and illustrate how symbiosis has made it possible for a diversity of life forms to exist in an environment with limited resources
Relationships between predator and prey species	The student can • describe how predation affects the growth of a population • explain the effect of mimicry • construct a graph illustrating predator-prey relationships • evaluate the role of camouflage	
Mixtures of populations that define communities may change over time or remain as a climax species	The student can • define succession and climax community • illustrate how a community is characterized by its populations • compare primary succession and secondary succession	The student can • design and perform an experiment to demonstrate interspecific competition or succession

Concept 6.4.3 Population *change* over time can be expressed in quantitative terms.

	Acceptable Standard	*Standard of Excellence*
Factors that influence population growth	The student can • define natality, mortality, immigration, and emigration • explain factors affecting natality and mortality such as age of sexual maturity, gender ratio, mate availability, gestation period, estrous period, litter size, clutch size, fecundity, food supply, availability of shelter, and water supply • compare the effect of biotic factors and abiotic factors on natality and mortality • show the relationships between natality and mortality • show the relationships between immigration and emigration	
The growth of populations up to the carrying capacity of their environments and the behaviour of populations with different growth patterns	The student can • define carrying capacity, environmental resistance, exponential growth, and logistic growth • interpret an S-curve or population-growth curve • illustrate how changes in the factors that influence population growth would affect a population-growth curve • interpret growth curves showing expansive or young populations, constrictive or declining populations, and stationary or stabilized populations • interpret population-age structure pyramids in terms of resource consumption • list the characteristics of r-selected and k-selected species • illustrate a survivorship curve for a species that is primarily r-selected or k-selected	The student can • devise a method for determining how a population of a given species should be managed in a prescribed area with reference to carrying capacity, life-history, age structure, methods of determining these, and costs/risks or benefits
The application of the "chaos theory" to the study of biological systems		The student can • outline the steps of the scientific method in order to stress the importance of isolating variables when making conclusions • outline the chaos theory • state the relationship that exists between chaotic events and outcomes of the scientific method

Biology 30 Information Bulletin

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